

REMARKS

The following remarks are responsive to the rejections raised by the Examiner in the non-final Office Action dated October 21, 2004.

Status Of Application

Claims 1-60 are pending in the application; claims 1, 28, 29 and 56-60 being in independent form.

Claims 2-4, 15-17, 28, 30-33, 35, 37, 40, 43-47, 52-56, 58 and 60 have been amended to clarify the claims, including, correcting numbering in dependent claims. No new matter has been added. Support for these amendments can be found throughout the specification. Entry and consideration of this Amendment are respectfully requested.

Office Action Dated October 21, 2004

In the Office Action, the Examiner made the following rejections to the claims. Claims 1, 9-15, 19-23, 28, 29, 37-43, 47-51 and 56-60 are rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,787,888, to Schotland (“Schotland”). Claims 2-8, 16-18, 24-27, 30-36, 44-46 and 52-55 are rejected under 35 U.S.C. §103(a) as being unpatentable over Schotland in view of U.S. Patent No. 5,865,754 to Sevick-Muraca et al. (“Sevick-Muraca”). Applicants respectfully traverse the rejections and request reconsideration for all of the reasons below.

Response To Rejections Under 35 U.S.C. § 102(b):

Claims 1, 9-15, 19-23, 28, 29, 37-43, 47-51 and 56-60 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Schotland. In rejecting the claims the Examiner stated, “Schotland discloses a method and a system for reconstructing an image of a scattering medium comprising [(1)] a source directing energy into the scattering medium at source location on the scattering medium, [(2)] a detector for measuring the energy emitted from the scattering medium at a detector location on the scattering medium, [(3)] an internal properties of the scattering medium, [(4)] means for using an equation of radiative transfer to predict and generate a function of radiative diffusion through the scattering medium, [(5)] means for generating gradient of the objective function, [(6)] means for modifying the properties of the scattering medium based on the gradient of the objective function, and [(7)] means for generating an representation of the internal properties of the scattering medium.” The Examiner further stated that Schotland includes a method where “properties include at least one of scattering coefficient, an absorption coefficient, an anisotropy factor and a scattering phase function”. Applicants respectfully traverse the rejections.

All of Applicants independent claims, claims 1, 28, 29 and 56-60, are directed to reconstructing an image of a scattering medium and include, *inter alia*, (1) the use of the equation of radiative transfer, (2) generation of an objective function, (3) generating a gradient of the objective function using a method of adjoint differentiation, and (4) modifying an initial guess based on the gradient of the objective function. Contrary to the Examiner’s assertion and

citation, Schotland does not disclose, teach or suggest at least these four elements of Applicants' claims.

First, Schotland's invention is based on a time-dependent diffusion equation not the time-independent equation of radiative transfer that Applicants claim. The diffusion equation employed by Schotland makes numerous assumptions (e.g., neglecting the anisotropy factor and the scattering phase function) that, while making it easier and faster to solve, limit the practical use of Schotland only to media that is highly scattering. In contrast, Applicants' claims as presently presented employ the equation of radiative transfer which overcomes these deficiencies of Schotland. Applicants' use of the equation of radiative transfer provides the capability to image low scattering media as well as highly scattering media, media with high absorption, and media with void-like regions. This distinction is significant because it permits the Applicants' to more accurately image the brain which contains void-like space that are filled with low-scattering and low-absorbing cerebrospinal fluid, finger joints that contain low-scattering and low-absorbing synovial fluid, and a fetus in the female uterus that is filled with low-scattering and low-absorbing amniotic fluid. In all of these cases the tissue contains void-like regions in which the diffusion equation disclosed by Schotland fails. This equation also fails to describe light transport in tissues of small geometry, such as fingers or small animals.

Second and third, Schotland does not disclose the generation of an objective function or generating the gradient of the objective function in the image reconstruction process.

Applicants' use of the gradient of an objective function provides a nonlinear update of the optical properties (as compared to a linear update provided by Schotland's approach), which in general results in more accurate images. The Examiner's citation to Schotland describes how Schotland solves a system of linear equations of the form $Kf=g$, by minimizing $\|Kf-g\|$, where K is a matrix and f and g are vectors. While this is a widely employed way of solving a system of linear equations, it has no relevance to (i) Applicants use of an objective function in which the measured data is compared to the predicted data or (ii) Applicants' generation of the gradient of the objective function.

Fourth, Schotland does not teach or disclose modifying the initial guess of the medium's optical properties based on the gradient of the objective function. Indeed, Schotland specifically states that his approach utilizes "a direct reconstruction methodology," (col. 4 line 65 – col. 5 line 3). Unlike Schotland, Applicants claim an indirect image reconstruction algorithm, which iteratively employs a light propagation model for calculating predicted light intensities, an objective function for comparing measurements and predictions, and an updating scheme using the gradient of the objective function.

In addition to the advantages described above, unlike Schotland's which only discloses reconstruction of the absorption coefficient, Applicants' system and method are capable of also imaging other properties, including, the scattering coefficient, the anisotropy factor g and/or the scattering phase function $p(\cos\theta)$.

Applicant respectfully submits that for claims to be anticipated by a reference in terms of 35 U.S.C. §102, every element of the claimed invention must be identically shown in a single reference either expressly or inherently, and arranged as in the claims under review. Since at least the above referenced elements of each of Applicants' claims 1, 28, 29 and 56-60 are not disclosed in Schotland, reconsideration and withdrawal of the rejection is respectfully requested. Additionally, since claims 1, 28, 29 and 56-60 are believed to be allowable, and claims 9-15, 19-23, 37-43 and 47-51 depend from and further limit one of independent claims 1, 28, 29 or 56-60, claims 9-15, 19-23, 37-43 and 47-51 are also believed to be allowable.

Response To Rejections Under 35 U.S.C. §103(a):

Claims 2-8, 16-18, 24-27, 30-36, 44-46 and 52-55 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Schotland in view of Sevick-Muraca. Applicants respectfully traverse the rejections, request reconsideration of the claims and argue that the claims are not obvious in further view of Sevick-Muraca for at least the reasons discussed above. Specifically, because claims 1, 28, 29 and 56-60 are believed to be allowable, and claims 2-8, 16-18, 24-27, 30-36, 44-46 and 52-55 all depend from and further limit one of claims 1, 28, 29 and 56-60, claim 2-8, 16-18, 24-27, 30-36, 44-46 and 52-55 are also believed to be allowable.

CONCLUSION

Based on the foregoing remarks, it is respectfully submitted that the claims as amended are patentable and in condition for allowance, for which action is earnestly solicited.

Patent
Serial No. 09/767,230
Docket No. 0887-4150US1

If any issues remain, or if the Examiner has any suggestions for expediting allowance of this application, he is respectfully requested to contact the undersigned at the telephone number listed below.

Favorable consideration is respectfully requested.

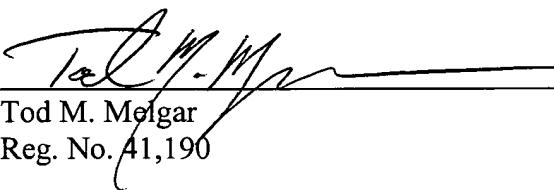
Patent
Serial No. 09/767,230
Docket No. 0887-4150US1

AUTHORIZATION

The Commissioner is hereby authorized to charge any additional fees which may be required for consideration of this Amendment to Deposit Account No. 13-4500, Order No. 0887-4150US1. A DUPLICATE OF THIS DOCUMENT IS ATTACHED.

In the event that an extension of time is required, or which may be required in addition to that requested in a petition for an extension of time, the Commissioner is requested to grant a petition for that extension of time which is required to make this response timely and is hereby authorized to charge any fee for such an extension of time or credit any overpayment for an extension of time to Deposit Account No. 13-4500, Order No. 0887-4150US1. A DUPLICATE OF THIS DOCUMENT IS ATTACHED.

Respectfully submitted,
MORGAN & FINNEGAN, L.L.P.

Dated: April 20, 2005 By: 

Tod M. Melgar
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